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RESEARCH WAS DONE ON CURRICULUM DEVELOPMENT IN VOCATIONAL EDUCATION, STUDYING AN APPROACH WHICH STRESSES TEACHING GENERAL SKILLS, KNOWLEDGES, AND UNDERSTANDINGS BEFORE VOCATIONAL TRAINING FOR A SPECIFIC JOB IS PURSUED. TWO INDUSTRIAL CLASSIFICATIONS WERE DEFINED FOR STUDY--(1) AGRICULTURE RELATED AND (2) NONAGRICULTURE RELATED, INCLUDING THE METAL INDUSTRIES. USING THESE CLASSIFICATIONS, THE CURRICULUM RESEARCH OF THIS PROJECT CENTERED ON PROBLEMS OF JOB CLUSTERING AND ON THE IDENTIFICATION OF SKILLS AND ABILITIES COMMON TO A NUMBER OF JOBS. THIS RESEARCH WAS DISCUSSED UNDER THE THREE HEADINGS OF (1) JOB ANALYSIS STUDIES, (2) STUDIES OF PSYCHOMOTOR FACTORS, AND (3) STUDIES OF COGNITIVE FACTORS. (GD)

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INTERIM REPORT

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Douglas Sjogren
and
Robert Sahl

December 1966

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INTRODUCTION

Many agencies such as vocational schools, industry, the military, public schools, and unions have considerable responsibility in training persons as competent workers in many occupations. Significant problems are associated with the discharge of this responsibility, not the least of which is the problem resulting from the knowledge explosion and the technological revolution. This rapid occupational change is evidenced not only by the large number of jobs that are becoming obsolete but also by the even larger number of new jobs coming into existence each year.

Any agency that is developing and using training programs or vocational curricula is certainly concerned with the program being as efficient and effective as possible. In order to accomplish this, however, the curriculum developer faces a dilemma. Obviously, curricula cannot be developed for every occupation. Two alternatives then seem to be available to the curriculum planner. On the one hand the curriculum can be developed on the basis of certain specific occupations. This kind of curriculum would reasonably be effective and efficient on a short term basis for any individual because the training program would contain only content specific to an occupation with little or no material included that is not essential to the performance of a specific job. When viewed on a long term basis, however, a curriculum designed to train for specific occupations may not be as effective or efficient as an approach that would not be geared to any one occupation, but would teach skills, knowledge, and understandings of relevance to a number of similar occupations. This approach would be desirable in the sense that the individual who went through such a program would have the basic skills, knowledge, and understandings for a number of occupations. Furthermore, such training would be especially efficient when the individual is forced to change jobs because it could be expected that the generalized approach would reduce subsequent retraining needs.

The presentation so far indicates that the choice is dichotomous; either a program for specific occupations, but specific to none. That such a dichotomous situation is not necessary or even possible is obvious. A curriculum designed to train for specific occupations will contain activities that allow skills to be developed that are generalizable to other jobs, but their outcome is incidental and not planned. On the other hand, the person who has gone through a training program designed to teach material of relevance to a number of occupations will need additional specific training for any job he may enter. It is difficult to imagine any but the most menial job not requiring some kind of on-the-job training.

On the face of the above description, and at the risk of oversimplifying a complex problem, it would appear that the more logical approach to curriculum development in vocational education is the one that teaches the general skills, knowledges, and understandings first as a basis for allowing training in a number of specific jobs. Curricula geared to specific jobs will allow generalizable skills to be taught, but this is likely to be an incidental rather than planned situation. Furthermore, not all of the generalizable material will be relevant to the same jobs with the result that the trainee will have bits and pieces of information of limited applicability to a whole host of jobs rather than a relatively comprehensive and well-integrated background for a number of related jobs.

The basic assumption for this technical report and the research program that we are pursuing, then, is that vocational curricula designed to teach skills, knowledge, and understandings relevant to a number of jobs followed by specific training for a single job are more efficient and effective than vocational curricula designed to teach certain specific jobs. The remainder of this technical report is a discussion of the problems inherent in such a curriculum approach along with a review of literature and research relevant to the problem. Hereafter in the report the term "general curriculum" will be used to refer to a vocational curriculum designed to teach skills, knowledges, and understandings relevant to a number of jobs.

An obvious question for the developer of general vocational curricula is, "How general is general?" The very general approach would result in a curriculum much like the general academic curriculum now used in our schools. Certainly the content of a general academic curriculum is relevant to the requirements of jobs, but past experience has indicated that many who have taken a general academic course are ill-prepared to enter many occupations. Why the academic curriculum does not work well as vocational preparation is not immediately apparent, but certain factors, taken independently or in interaction with each other, do seem to provide possible explanations. Among these are:

1. The lack of concrete situations to illustrate the application of skills, knowledge, and principles.

2. The heavy concentration of verbal learnings with little emphasis on motor and sensory training.

3. The difficulty in transferring from the general to a specific situation without a conscious effort to teach for such transfer.

4. A lack of knowledge of the world of work and the application of knowledge to job situations on the part of teachers in the academic areas.

5. Inadequate learning on the part of the students, perhaps related to the students' not regarding the academic content as being meaningful.

Whatever the reasons, it does seem apparent that the general academic curriculum as presently conceived is too general to serve effectively as a general vocational curriculum.

Rather than attempting to define a general vocational curriculum on a rational basis, the more reasonable approach is to define a general vocational curriculum on the basis of observable similarities among jobs in terms of skills, abilities, tasks, and competencies. With such an approach, job clusters would be identified or defined on the basis of each job in the cluster having relatively high commonality of required skills, tasks, abilities, and competencies with the other jobs in the cluster. The general vocational course for this job cluster would then be designed to teach the factors common to those jobs in the cluster. The training for specific jobs would follow the general course and would consist primarily of experiences designed to teach those specific factors not included in the general curriculum. If many general vocational courses were available then it would be quite likely that certain of the specific factors might be provided for in the general material of other job clusters.

The first step in developing a general vocational course or curriculum is that of identifying job clusters. This step entails some rather involved methodological problems and decisions among which are the following. 3

1. What methods are available for identifying job clusters? Judged similarity of job descriptions, factor analysis, and multi-dimensional scaling are all methods that have been used and may be appropriate.

2. What are the relevant variables to introduce into a job clustering procedure? How precisely should one attempt to define a job? What scale should be used?

3. How similar should the jobs be to each other to be considered members of a job cluster? Is a degree of congruency needed on many factors or will high congruency on one factor compensate for low congruency on another factor?

4. What does one do when a job seems to load equally well on two job clusters?

5. Do we measure job characteristics in terms of tasks done on the job or do we measure the behavior of workers on the job?

6. Does the data needed require observation of a worker on the job or can the information be obtained by more economical procedures such as questionnaires or interviews?

7. How does one decide on the jobs to be included in the clustering procedure? (e.g. industrial classification or occupational classification)

These are several of the questions that have concerned us in our research program designed to determine whether common behavioral factors can be identified among jobs in an industrial classification and whether, if identifiable, they can serve as bases for designing curricula to train persons for gainful employment in the industry. Two industrial classifications were defined for the study; agriculture related, including production agriculture, and industries in which the processing and/or fabrication of metallic substances is a major purpose.

Considerable research has been done on problems relevant to job clustering or the identification of skills and abilities common to a number of jobs. Much of this work has seemingly been done independently in that there are few explicit attempts to relate the findings of the various studies. One aspect of our research program was to review the relevant literature and attempt to synthesize the information available from the various sources. This technical report is an attempt to do this task.

The studies are discussed under the three general headings of Job Analysis Studies, Studies of Psychomotor

Factors, and Studies of Cognitive Factors. This grouping was in fact the basis for our decision as to the content of the research that was to be reviewed for the project. It was reasoned that Job Analysis type studies would have the most relevant information for our purposes, but that certain studies of psychomotor and cognitive factors should also be included because of the relevance of such studies to the tasks, skills, knowledge and understandings required in work behavior.

JOB ANALYSIS

The literature on job analysis is quite extensive. A Job Analysis Bibliography developed by Joseph E. Marsh in 1962 lists 1,511 references in the area. (Marsh, 1962). The bibliography covers the 50 year period from 1911 to 1961. We have not attempted to review all of the job analysis literature; rather we have attempted to study the research and theoretical writings that seemed most relevant to our problem. No claim is made either that the review is exhaustive, but we do believe we have become familiar with most of the significant work in the field that is related to identification of job clusters.

The organization of this section of the report was a problem. We attempted to classify the articles into categories such as methodological studies, clustering studies, industrial areas, etc. Because of overlap and difficulty in classifying, we decided to group the studies according to institution or agency within which the study was conducted, job evaluation studies, a theoretical category, and a miscellaneous category. The final part of this section contains an attempt to synthesize the material reviewed.

Three groups of researchers seem to be doing a majority of the work in job analysis in terms of identifying job clusters and commonality of skills and abilities across jobs. The three are the U. S. Employment Service, the Personnel Research Laboratory of the Air Force Systems Command, and a group in the Industrial Psychology Department at Purdue University. The research of each of these groups is reviewed separately in the next part of this section.

U. S. Employment Service

The 1965 edition of the Dictionary of Occupational Titles (DOT) was the culmination of a very comprehensive program of research by the Employment Service. Many articles were written which reported the research results and the progress made in the development of the DOT. It was interesting to note the development of the classification scheme as presented in the DOT, and this reviewer was impressed with the empirical approach and the flexibility of thinking of the researchers in their work on the DOT.

Studdiford (1951) described the reasons for revising the DOT and the preliminary thinking on the content of the revision. Apparently one of the limitations of the second edition of the DOT was that it classified applicants only in terms of specific occupations. Studdiford stated that the occupational classification scheme in order to be of maximum value in the counseling, selection, and placement of workers, ". . . must group jobs which are alike with respect to fundamental work activities and worker requirements." Although the terms as such are not used, it does appear that the job family or job cluster concept was in the thinking of the developers of the new DOT.

The proposed classification scheme for the project, which became known as the Functional Occupational Classification Project (FOCP) included eight components. The components were: (1) work done, (2) knowledges and abilities, (3) aptitudes, (4) physical demands, (5) temperamental demands, (6) working conditions, (7) industry, and (8) training time. Each of these components was broken down further into factors or levels. The basis for the components and factors or levels is not apparent in the article, but in a later article Studdiford (1953) indicated that the components were arrived at on a rational basis in a series of conferences. The factors and levels for the components were based on data from employment service, industrial, and psychological research.

As one reads the reports of the FOCP he is impressed with the difficult task that they carved out for themselves. In effect, they were faced with reclassifying some 40,000 jobs on the components and factors of the new classification scheme. Considerable information was available on most of the jobs from the many job descriptions that had been accumulated since the start of the Employment Service and the descriptions in the second edition of the DOT. The problem then was whether the available job descriptions could be used for the new classification scheme or would it be necessary to observe the jobs again using the new classification scheme.

Trattner, Fine, and Kubis (1955) studied this problem with respect to the aptitude component. Two groups of eight job analysts rated 10 jobs on the degree to which 10 aptitudes are required for average satisfactory performance. Each aptitude was rated on a five point scale. The analysts had equal training and experience. One group rated the jobs on the basis of job description materials, and the other group made their ratings on the basis of direct job observation. In addition, GATB scores on the 10 aptitudes were available from 60 workers in each of the 10 jobs. From their results the authors concluded that the ratings by either method were satisfactory in terms of self-consistency and that there was a high degree of correspondence between the mean ratings made by the two groups. They also reported a satisfactory degree of consistency with the GATB results, but the reviewer questions whether the correlation of .01 and .27 respectively between the physical aptitude scores on the GATB and the descriptive raters and the direct observation raters is indicating much consistency. The mean scores made by the workers on the GATB, however, were probably not a very useful validity criterion, and the important point of the study was the demonstrated comparability of the two methods in terms of self-consistency and magnitude of ratings.

Another study (Newman and Fine, 1957) compared ratings based on direct job observation and ratings based on job descriptions. The ratings were of physical capacities and working conditions, and the correlations between the two methods of ratings were high.

A study that was apparently unpublished, but reported briefly in Fine and Heinz (1957), indicated the two methods of ratings yielded similar results when general educational development and specific vocational preparation were rated.

Two articles by Fine (1955A, 1955B) described the functional job analysis system developed by the U. S. Employment Service for the Functional Occupational Classification Project. The system was designed to analyze the component of work performed in terms of the worker function, the materials, products and subject matter of the job, and the methods groups. In effect the system attempted to describe the "what, how, and why" of the job. The worker function aspect of the system was described quite explicitly in the articles. Twenty-six action verbs were extracted from a list of 900 separate verbs to define worker functions. The twenty-six verbs were defined in three hierarchies relating to Things, Data, and People. Two of the verbs, observing and learning, were considered to be applicable to all situations and eight verbs represented the hierarchy under each of the categories of Things, Data and People. The hierarchical arrangement was such that each verb in a category going up the hierarchy implied a function inclusive of the function implied by the verbs at lower levels.

The Worker Function system was used to classify 4,000 jobs and the results indicated that the system was useful. As originally conceived, the job analyst judged the level in each hierarchy at which a worker was functioning and then judged what proportion of the job was devoted to the function. The Worker Function rating procedure, as finally used in the DOT, involved only the judgment of the level with no judgment of proportion of time. This reviewer was not able to find a research report which indicated the reason for dropping the proportion of time judgment from the rating procedure.

Fine and Heinz (1957) reported on ratings of six worker trait components for the 4,000 jobs mentioned above in connection with the Worker Function ratings. The six trait components were training time, aptitudes, temperaments, interests, physical capacities, and working conditions. The 4,000 jobs were an 18% sample of the _Dictionary of Occupational Titles_. Ten experienced occupational analysts rated samples of the jobs on the six worker traits. The ratings were made from job descriptions in the DOT and other descriptive sources using rating manuals that had been developed by the U. S. Employment Service. High interrater consistency was observed in rating the traits on the samples of the jobs. Ratings were then made of the entire sample of 4,000 jobs on the six worker trait components.

Results of a study comparing the U. S. Employment Service Occupational Classification system and the Minnesota Occupational Rating Scales (Fine, 1957) indicated that the USES system of rating trait components and worker functions provided discrimination among jobs. Further the two systems of rating job requirements yielded consistent results.

In 1958 the new occupational classification system was presented as a three part, nine digit code (Fine and Heinz, 1958). The first part was a three letter code to indicate the level of functioning and the relative involvement of the worker with Things, Data, and People. The second part of the code was a three digit number to indicate the work field, and the third part of the code was a three digit number representing the material, product, subject matter, or service with which the worker was primarily involved. With such a system it was possible to group or arrange jobs in a variety of ways simply by sorting on any part of the code.

The nine digit code was not retained in the DOT presumably because the six digit code was considered as useful and less complex than the nine digit code. This reviewer has not located any articles which indicated the basis for the shift, but some explanatory material in the DOT suggested that certain parts of the nine digit code were highly correlated and providing more redundancy than was necessary.

The six digit code of the DOT provides the following information. The first digit represents one of nine occupational categories, and the first two digits represent one of 84 occupational divisions in terms of subject matter, activity, products, services, or areas of work depending on the occupational category. The first three digits represent one of 603 occupational groups with the groups more specifically defining each division. The last three digits of the code indicate the level of each hierarchy at which the worker is required to function in relation to Data, People, and Things. Rather than code in terms of worker trait components, 114 worker trait groups have been defined. Each group is such that the occupations in the groups are common in terms of the traits and abilities required of the workers.

The 1965 edition of the DOT was the culmination of a tremendous research program on the part of the personnel involved. It would appear that this edition will be very useful for counseling purposes and also for grouping occupations in various ways. We intend to introduce the variables of the eight work components into our analysis scheme by using the data on these variables in the DOT as it pertains to the job titles we include in our study.

The Functional Occupational Classification System has been criticized by Walther (1960). He tested the system against data available on two different types of jobs and concluded that the FOCP did not get at certain rather critical dimensions of these jobs. The dimensions were primarily personality factors which are only rated on a superficial basis as the temperament and interest components of the FOCP. Walther criticized the interest component of the FOCP further in terms of its theoretical basis. Although Walther concluded the FOCP was a "substantial contribution to occupational knowledge by emphasizing through its temperament and interest components new dimensions of the world of work beyond those considered by conventional job analysis" he apparently felt that it had not gone far enough in this respect. This reviewer, however, wonders whether further progress in applying personality dimensions to job analysis is not limited greatly by measurement problems in scaling or rating these dimensions reliably.

Although not directly related to the procedures of the FOCP, two articles by Fine (1957B, 1957C) contained some points about transferability of skills that were relevant to our project. In the first article, Fine questioned whether an emphasis on transferability of skills in training to achieve efficiency and economy in training was justified. He apparently believed that much more knowledge was needed about the variables that influence transfer beyond the obvious similarities in machines, materials, and type of work. The second article described how the FOCP attempted to or could be used to study the problem of transferability of skills. Fine raised some valid points with respect to transfer, and the reviewer agrees that much research is needed on the variables that affect transfer. The reviewer does not agree, however, that we need to wait for this knowledge before we can attempt to design training programs that will train in skills and knowledges that might generalize or transfer across a number of occupations.

U. S. Air Force Studies

The Personnel Research Laboratory of the Air Force Systems Command at Lackland Air Force Base, Texas, is conduction a program of research which is very relevant to our interests. A monograph by Marsh, Madden, and Christal (1961) described the job analysis procedure used by the Air Force and the purposes of the analyses. Among the 13 listed purposes was one which indicated that the analyses were "to be used in the development of job training standards, course training standards, or for the revision of training curricula."

The Air Force method of job analysis was referred to in the monograph as an eclectic method. In this method jobs are analyzed into three basic components; position, duty, and task. A position is a grouping of duties and responsibilities which comprise the principal assignment of one person; a duty is a large segment of work done by an individual, and a task is a unit of work activity which forms a consistent and significant part of a duty. A task is usually described by a statement consisting of a verb and an object. This is similar to the worker function component of the FOCP.

In the Air Force system, the basic instrument is a Duty and Task Inventory. This inventory is developed usually for the purpose of surveying the duties and tasks of all specialties within one career ladder. The first draft of the inventory is written from information provided in job descriptions, job training standards, and other sources. This draft is then reviewed by technical advisers (persons who are very familiar with the job) who revise, delete, or add duty and task statements. The final form of the survey is then constructed and administered to a sample of incumbents in the specialty and career ladder to be surveyed.

Three responses are requested from the incumbent for each task. He checks whether the task is done, the time spent on the task, and the training and experience required to perform the task. The last two responses are scaled on a relative scale.

Considerable research is reported in the monograph to support the Air Force method of job analysis. Several studies were reported on the reliability of task inventory information. The reliability data indicated that

1. Frequency of task occurrence was reported more reliably than any other task information.

2. Whether or not tasks were performed was reported more reliably when incumbents were required to make estimates on relative rather than absolute scales.

3. Task occurrenc was reported more reliably over a six month test-retest period than a period of one month, but the reliability was greater over the shorter period for the reporting of time required and task difficulty.

4. Response consistency was related to the degree of specificity called for in the response. Quantitative data was reported more consistently when the response was quite specific, but qualitative information was reported more consistently when the response was quite general. Madden (1960) reported more reliable ratings of knowledge required on a job when the ratings were made separately of four dimensions of knowledge than when a global rating of knowledge was made.

5. The amount of information about tasks for which reports are required was not related to the number of tasks reported, but the number of tasks reported was positively related to the reliability of the responses.

Validity data on the task and duty inventory was rather scanty. Evidence was reported that indicated the inventory yielded information that was consistent with information gathered in observations, interviews, and self-administered performance reports.

Information about the reliability of certain scaling procedures was also presented in the monograph. Ratings or judgments of time spent on tasks whether in terms of proportions or amount were made more reliably when relative scales were used than when absolute scales were used. Test-retest reliabilities for judgment of difficulty of tasks were quite low. The frequency with which a task was performed was judged reliably either on relative or absolute scales.

A technical report written in 1963 described further research on the construction of the Air Force job inventories. (Archer and Fruchter, 1963). The study indicated that the following steps provided for efficiency in construction of a satisfactory task and duty inventory.

1. Prepare a duty outline and write task statements. The main sources for the outline is the Job Training Standard. Task statements should begin with a present tense action verb and unnecessary qualifiers should be avoided.

2. Have technical advisers review the inventory in three steps. First a field review in which the inventory is sent to a number of individuals who are familiar with the job for their review, then a review in an interview situation with a few technical advisers, and finally a review in a group situation with additional technical advisers.

3. Administer the inventory to job incumbents. The inventory should provide the incumbent with an opportunity to write in task and duty statements. Certain information seemed to be provided by the incumbents in lower level jobs that had not been obtained in the reviews by higher level personnel in the technical reviews.

Another report contained information that was somewhat contradictory of this last point, however.

Christal and Madden (1961) reported research results to indicate that lower level incumbents did not provide reliable ratings of their own job. Other results reported in the Christal and Madden paper were:

1. The mean of ten to fifteen raters provided an acceptable degree of rating stability.

2. There was no clear relationship between degree of familiarity with a job and the accuracy of ratings of the job. There was evidence of a positive bias among raters with work experience in the job which suggested that raters without work experience in the job were desired especially in job evaluation work.

3. Halo effects were observed among raters and across jobs.

4. Ratings of jobs changed with increased information.

5. Averages of independent ratings provided nearly identical information with consensus ratings.

The Christal and Madden report was especially relevant to job evaluation procedures rather than job description, but the reported findings certainly are relevant to the methodology of any job analysis whatever its purpose.

Three methods of constructing rating scales were compared by Madden (1960) as part of the Air Force project. The three methods were:

(a) Each of six scale levels of a factor to be rated was defined in detail and illustrative examples of each level were provided. In addition the factor was defined very explicitly.

(b) The factor was defined as in the above method, but the scale levels were defined only with numbers from 0 to 5.

(c) The factor definition was shortened, and the six levels of the scale were defined briefly without examples. Methods "a" and "c" were generally superior to method "b" in terms of reliability although mean ratings of the scales did not differ significantly in all instances but one. The author suggested that the use of Method "c" was indicated because the reliability of this method was as high or higher than the other methods and the method required less time of the rater than method "a".

An interesting and seemingly promising method of job grouping has been developed in connection with Air Force personnel research. A least-squares procedure is used to group jobs on the basis of the percentage of time spent on each rated task. (Ward, 1961). Some reports of the application of the method are available, and the method does seem to group jobs in a meaningful way. (Marsh, 1965; Christal, 1965) It would seem desirable to compare the results of this method with other methods such as factor analysis, cluster analysis, and multi-dimensional scaling.

Purdue Studies

A number of studies have been conducted in the Industrial Psychology Department at Purdue University which have been concerned with patterns of job requirements. Much of the research has been directed at the problem of classifying jobs on the basis of certain personal characteristics which the job required of the incumbent for reasonably satisfactory performance.

McCormick, Finn, and Schieps (1957) attempted to classify 4,000 jobs on the basis of certain factors that emerged from a factor analysis of 44 variables. The 44 variables were the variables used to rate six of the components used by the U. S. Employment Service in the FOCP. The six components were training time, aptitudes, physical capacities, temperaments, interests, and working conditions. Ratings of the 4,000 jobs on each of the 44 variables had been done in the USES study. Seven factors emerged from the factor analysis; mental and educational development vs. adaptability to routine, adaptability to precision operations, body agility, artistic ability and esthetic appreciation, manual art ability, personal contact ability vs. adaptability to routine, and heavy manual work vs. clerical ability. Each of the jobs was then given a factor score on each of the seven factors by the Wherry-Doolittle test selection method. Each of the factors was then broken down into two or three levels and the patterns of job requirements were established on the basis of high or low level on each factor. All possible permutations would have allowed 192 unique patterns, but the jobs fell into only 115 patterns. Only 12 patterns accounted for 60% of the jobs and 33 patterns accounted for 88% of the jobs. Apparently there was considerable commonality among the jobs on the seven factors identified in this study for purposes of classification.

Five doctoral studies at Purdue have been directed at problems similar to that in the McCormick, Finn and Schieps paper (Schieps, 1954; Finn, 1954; Johnson, 1957; McCracken, 1959; Gordon, 1963). The Finn and Schieps studies apparently provided some of the data for the McCormick, Finn, and Schieps paper. Johnson attempted to identify variables that could be used to provide a meaningful basis for categorizing jobs. A factor analysis revealed eight dimensions in which jobs dealing with vehicle maintenance and garage operations could be categorized. The titles given to the factors suggested that two of the dimensions were quite general (general mechanical activities and inspection, diagnostic and analytic activities), but the other six seemed quite specific to the jobs surveyed.

McCracken attempted to cluster jobs on the basis of 58 variables developed under six major headings.

A cluster analysis was made of the intercorrelation matrix developed from the 58 variable check list. Four persons filled out the check list from jobs in two manufacturing concerns. Nine job clusters were identified; machining, processing, assembling, forming, planning, finishing, cleaning, stock handling, and laboring.

Gordon conducted a factor analysis type study of 400 jobs which were taken from the DOT to be representative of the major occupational areas. Check list type ratings were made on each of the jobs on 20 items related to activities associated with people, mediating processes, and outputs. Five factors resulted from the analysis as dimensions on which jobs might be classified. The factors were mediation activities, physical output activities, communications activities, situational aspects, and environmental aspects.

Palmer and McCormick (1961) conducted a factor analysis of a 177 item checklist which had been used to rate the worker activities on a stratified sample of 250 jobs in a firm that had some 10,000 jobs. The checklist contained items on information-receiving activities, mental activities, supervisory and communications activities, manual activities, general bodily activities, general work conditions, and general job characteristics. The checklists were completed from job descriptions and a reasonable level of inter-rater agreement was obtained. The analysis was conducted in two stages. The initial analysis consisted of a separate factor analysis of the items in each of the first five areas indicated above. This analysis yielded fourteen oblique factors. Factor scores were then computed for each job. The 14 factors were then intercorrelated using the job scores along with 14 variables measuring work conditions, job characteristics, and educational development. This 28 x 28 matrix was then factor analyzed and four factors were identified. The four factors were named general decision making and mental activity, sedentary vs. physical work activity, communications in business management vs. information in routine physical work activity, communications in business management vs. information in routine physical work, and knowledge of tools vs. mathematics.

McCormick (1964) wrote a report that summarized a series of exploratory studies relating to worker oriented job variables of which those cited above were a part. The studies were attempts to describe or characterize jobs in terms of worker behavior rather than in terms of the technological processes or operations that are carried out in the job. The basic format or instrument for the studies was the Worker Activity Profile. The profile contained 162 worker activity items divided among nine categories of discrimination activities, mental activities, body and limb activities, supervisory activities, communications and interpersonal relations, rhythm of work activities, general characteristics of the job activities, physical environment, and psychological and sociological aspects of the job. Some items of the profile were scaled for a dichotomous response and other items were scaled on a continuum.

Two samples of jobs were rated with the profile. One sample consisted of 400 jobs selected to be reasonably representative of the number of jobs in the major occupational groups of the DOT. The other sample of 371 jobs were selected on the basis of proportions of workers in these various occupational groups as reported in the 1960 census. Twenty-five jobs were common to the two samples. The profile was completed for each sample by rating the jobs from job descriptions. A factor analysis was made of the data in each sample using 119 of the 162 items. In addition, five separate analyses were made in each sample of the following subgroups of items: mediation activities, physical output activities, communications activities, situational aspects, and environmental aspects. The results of the two studies were presented in Cunningham and McCormick (1964) and Gordon and McCormick (1963). The McCormick report contained a comparison of the two analyses. There was considerable agreement between the results of the two studies both in terms of the overall factor analysis and the separate subgroup analyses. Some of the general worker activity factors were decision making and communication activities, hierarchial person-to-person interaction, skilled physical activities, mental vs. physical activities, responsible personal contact, man-machine control activities, and pleasant vs. unpleasant working conditions. The technique and the instrument developed in these studies seem to be useful for describing and categorizing jobs in terms of the behavior of the worker. Attempts to validate the instrument against other ratings of job attributes and to apply the instrument in job evaluation were not as successful as might be desired, however, and it would appear that the approach needs further research before one can use it confidently in categorizing jobs.

General Job Analysis Studies

Several investigators have been interested in the problem of developing procedures for classifying jobs by identifying underlying characteristics or dimensions that are common to a group of jobs. This section of the report reviews some of the studies that have been conducted in this area using general samples of jobs.

Coombs and Satter (1949) conducted one of the first studies in which the factor analytic approach was used in an attempt to identify job families. In the study, 70 jobs were analyzed by a trained job analyst from information obtained in interviews with the employee, the supervisor, the department head, and from observations of the employee at work.

The instrument used in the analysis required that the analyst make judgments of 18 areas of skill or knowledge required on the job. The 18 areas were each broken down into elements, which were phrases or statements reflecting various degrees of skill or knowledge. There were 104 such elements in the instrument arranged among the following skill categories: educational, work, application, social and personal, and activity distribution. Correlations were computed among 54 of the jobs (16 were dropped because of similarity) on the basis of the number of elements that were checked in common for the jobs. A 20 x 20 correlation matrix was then developed for the factor analysis. The 20 variable matrix included those jobs that had the lowest sums of correlations with all the other jobs. The factor analysis of the 20 x 20 matrix yielded five interpretable factors, four of which suggested job families with the fifth being a general factor. The four job family factors were self-responsible jobs, routine entry occupations, skilled machine operation jobs, and clerical jobs. The general factor outcome suggested a relatively high degree of commonality of skills even among the apparently heterogeneous sample.

A worker characteristics form was factor analyzed by Jaspen (1949). Two hundred seventy-five occupations were rated with the form which contained 45 items that estimated the existence of traits of workers on a four point scale. All traits or items that were judged to be present in more than 10% of the jobs were included in the analysis. This step resulted in the retention of only 20 of the original 45 items. The ratings for the 20 items plus a skill and two job characteristics items were intercorrelated using tetrachoric correlation. The factor analysis of the 23 x 23 matrix yielded six meaningful factors: strength, intelligence, inspection, working conditions, manual dexterity, and mechanical information. These factors can be regarded as dimensions along which jobs can be classified.

Orr (1960) studied a method for clustering jobs that used the D statistic where D is a generalization of the geometric formula for the distance between two points in a plane. Two samples of 140 jobs each were rated in terms of the extent to which verbal, numerical, spatial, form perception, clerical perception, motor coordination, finger dexterity, and manual dexterity aptitudes were required on the job. A third sample of 28 jobs, four chosen at random from each of the seven code areas of the DOT, was also rated with this procedure. The use of the D statistic provided a meaningful clustering of jobs. Three kinds of clusters appeared; intellectual-supervisory, mechanical-manual, and clerical. More specifically, six clusters were obtained in the study; high level technical, supervisory, and mechanical jobs, very high level jobs, fairly high level skilled jobs, clerical jobs, mechanical-manual jobs, and low level unskilled jobs.

Thorndike (1952) described a procedure similar to that used by Orr. This procedure seems to be the basis for the hierarchical grouping procedure mentioned earlier in this report as being used by the Air Force.

A multidimensional scaling approach to job clustering was reported by Gonyea and Lunneborg (1963). The study was actually an attempt to determine the perception of similarity of jobs, but this is not dissimilar to clustering. In an earlier study Gonyea (1961) had used the method of nonserial matching (Case III of the A technique) to explore the dimensions underlying job perceptions. In the Case III method, the subjects chose which of 29 occupations was most similar to the 30th occupation. This was done using each of the 30 occupations in turn as the basis of comparison. These data were used to estimate intercorrelations and the resulting matrix was factor analyzed. The analysis yielded meaningful factors of job perception. The nonserial matching technique was judged to be not completely satisfactory, however, in that the subjects had difficulty in using it and considerable data had to be discarded. The 1963 study was then done using Case II of the A technique, the method of triads. In this method, the stimuli are presented in groups of three and the subject indicates which of the three stimuli does not belong. This method is simpler for the subject to understand than the Case III method, but it also takes considerably longer for the subject to complete.

In the study using Case II, 22 occupations were selected for investigation. Eight of the occupations were chosen to represent the first order factors of the Case III study, four of the occupations were among those that loaded on more than one factor of the Case III study, and the remaining ten were occupations which are commonly listed as vocational objectives by college students. The 22 occupations when presented in triads yield 1,540 possible triads. Twenty forms of a Job Perception Blank were constructed with 77 of the possible triads on each form. The 20 forms were distributed randomly to 2,424 college freshman so that each form was completed by an average of 121 subjects. The factor analysis of the estimated correlation matrix of the 22 jobs resulting from the judged similarities yielded seven factors. Five of the factors appeared to be significant. An attempt was made to fit the five factors to the five second-order factors obtained in the first study, and this was accomplished rather successfully. The two analyses indicated that the occupations used in the studies were perceived along the dimensions of business, technical, esthetic, service, and scientific occupations. These dimensions must be considered as indicating perceived rather than actual similarities. Thus, in terms of skills, knowledge, and abilities required by the occupations the clustering might well be quite different from a clustering based on how naive people, in terms of experience in the occupation, perceive them.

Job Evaluation Studies

Job evaluation type studies have relevance for the project in that such studies are often concerned with identifying the behaviors required for successful performance of a job. Consequently, reports of such studies could be expected to describe behavioral dimensions of jobs that might well serve as bases for job clustering.

Ewart, Seashore, and Tiffin (1941) investigated the influence and significance of the ratings of each of 12 traits on the employee's overall merit rating. The employees were rated on a five point scale for each of the following traits: safety, knowledge of job, versatility, accuracy, productivity, overall job performance, industriousness, initiative, judgment, cooperation, personality, and health. One thousand ninety-two ratings were used in the analysis. The tetrachoric correlation matrix of the 12 traits was factor analyzed, and three factors were obtained; a general factor called "ability to do the present job," a factor called "knowledge or skill possessed beyond the specific job requirements," and a health factor. The investigators suggested that job evaluation ratings might well be made on two or three factors rather than on the 12 traits. This suggestion seems to disregard the question of reliability of the ratings, however; a point which the Madden (1960) study investigated as reported earlier among the Air Force studies.

Moore (1944) discussed the methods of job evaluation used at that time and the advantages and problems associated with each. His description of the four types of evaluation used at that time suggests that the basic procedures have changed little since 1944 except for an increased level of sophistication in applying some of the procedures. The four types of evaluation described by Moore were:

a. Job classification - a method in which jobs are placed into a few broad classifications such as unskilled, semi-skilled, skilled, and administrative.

b. Job ranking - a method in which jobs are ranked in order of their value to the organization.

c. Job elements - a method in which each job is reduced to the elements of the job and the relative amount of time spent on each element of the job.

d. Point evaluation - a method whereby all jobs are reduced to a number of factors which are expressed in varying degrees in the different jobs. Each job is then described and rated in terms of the extent to which it loads on the common factors.

Moore indicated that the point evaluation procedure was the most commonly used at that time, and his disucssion suggested that this method was the most desirable of the four in that it incorporated all of the advantageous features of the other types with fewer disadvantages.

Lawshe and Satter (1944) factor analyzed the job rating systems used in three industrial plants in an attempt to identify the basic factors operating in each system and the significance of each factor to the total point rating. Factors identified from the analyses included skill demands, job characteristics, job characteristics--non hazardous, job characteristics--hazardous, and attention demands. Only the first factor, skill demands, was found in all three systems. The others were specific to one or two systems. This result was likely due either to different instruments used for the rating or to actual differences in the jobs or both.

Rogers (1946) performed an analysis similar to the one conducted by Lawshe and Satter with two separate evaluation plans. One evaluation system for factory jobs included items in six areas and the other system for office jobs included items in ten areas. One hundred seventy factory jobs and 295 office jobs were rated and the results analyzed separately. The results in both analyses yielded a general factor of "skill demands" which accounted for most of the variance in job grade. The other factors were small and ambiguous and Rogers suggested that ratings on dimensions other than skill demands may be weighted too much in job evaluation.

The problem of the reliability of job evaluation rankings was studied by Ash (1948). Trained job analysts used 27 occupational descriptions to rank the occupations on nine factors independently. The nine factors were knowledge, physical skills, adaptability and resourcefulness, responsibility for the work of others, physical effort, attention, and working conditions. Ash concluded that a high degree of reliability of analyst judgment may be anticipated, but that reliability is related to the factor rated and the amount of job information available. He also suggested that a high degree of overlap of correlation between factors was not sufficient cause for dropping one from the evaluation scheme, but that the dropping of one or the other factor may lead to a different interpretation of the remaining factor.

Two methods of job evaluation were compared by Lawshe, Dudek, and Wilson (1948) to determine the basic factors involved in the two separate point-rating systems. The methods compared were the National Electrical Manufacturers Association Job Evaluation System and the Simplified Job Evaluation System devised by Lawshe. Forty jobs were rated in the study using both methods. Each analysis indicated that the two methods yielded similar results with the following five factors accounting for most of the variance: skill demands, supervisory demands, job characteristics--non hazardous, job characteristics--hazardous and job responsibility.

Oliver and Ulinn (1951) employed the Wherry-Doolittle multiple correlation technique of test selection to determine which factors of a job evaluation plan were contributing to most of the variance in the evaluations. The original plan contained 18 factors that were used to evaluate jobs of salaried personnel. Eighty-six salaried jobs were used for the study, and the results indicated that six factors related to skill, responsibility, and work conditions accounted for 98% of the variance in the evaluations.

Another analysis of a point-rating job evaluation plan was made by Grant (1951). Three hundred clerical jobs in a company were rated on each of 18 job factors. A factor analysis yielded 10 factors but it would appear from the loadings that only six of these are readily interpretable. The six factors were named skill demands, responsibility for effect on subsequent work, responsibility for financial decisions, supervisory demands, responsibility for confidential material, and work conditions. The skill demands factor accounted for nearly two-thirds of the variance in the ratings.

An experimental job evaluation system for enlisted naval jobs was studied by McCormick and North (1954). They were concerned among other things with identifying the factors which contributed to differences in job values and the relative importance of each factor. One hundred nineteen enlisted naval jobs were evaluated by a rank comparison system which included 13 factors that had been selected on a rational basis. The jobs were evaluated by 28 job analysts. The use of the Wherry-Doolittle test selection method yielded results to indicate that five factors contributed most in predicting a criterion of overall job worth. The five factors were work knowledges required, guidance and/or supervision received, potential hazards and hardships, inherent job hazards, and responsibility for the safety of others. The work knowledge factor accounted for a very high proportion of the variance.

A study by Myers (1965) yielded results to indicate that a halo effect due to job level affects the factor structure obtained in factor analyses of job evaluations. Eighty-two office jobs were evaluated on each of 17 job requirements or characteristics. These 17 characteristics were then intercorrelated and the matrix factor analyzed. He then partialed out the variance in the characteristics due to job level and factored the ensuing reduced matrix. The factor structures of the two matrices were similar except that the second method yielded more clear cut factors. The first factor especially was altered in that in the first analysis it emerged as a general factor but in the second it was possible to give it a specific interpretation. The factors identified were work complexity, interpersonal relations, physical components, confidential aspects, education level, and variety in work.

The job evaluation studies reviewed thus far have concentrated on job requirements. Although the purpose of job evaluation is not to cluster jobs it is apparent that the factors identified in such studies are dimensions that might be used for classification purposes. One obvious conclusion from the review of these job evaluation studies is that skill demands or complexity of work is the primary basis for evaluating jobs. This factor is not, however, very useful for clustering jobs because it lacks specificity. Perhaps this factor could be reduced somewhat into other components if a greater variety of jobs were included in the analysis. The other factors identified in the various studies seemed to be quite specific to the occupations studied and seemingly might serve as dimensions or categories for job clustering.

Another system for evaluating jobs or persons in jobs that has gained popularity in recent years is the Critical Incident Technique attributed to Flanagan (1954). In this technique job incumbents are evaluated on the basis of incidents in which they have been especially effective or ineffective in accomplishing parts of their job. In a sense the technique focuses on behavior rather than job characteristics. Several articles have been published regarding the use of the technique but most have been in terms of its use as an evaluative device. Anderson and Nilsson (1964) reported results to indicate that the technique yields reliable information and also valid information in the sense that the content of the incidents paralleled the content of other descriptions of the job very well. Although the technique has not been studied to any extent as a job classification system, it does seem reasonable that a basis for forming job clusters could be on commonality of critical incidents or behaviors among jobs.

Studies of Clerical Jobs

Clerical jobs have received a considerable amount of attention in job analysis type studies and a few of the studies are reviewed in this section.

Bair (1951) factor analyzed 17 clerical aptitude tests with an intelligence test in an attempt to discover the structure of clerical aptitudes. Actually 36 variables were included in the analysis in that two scores were obtained for each of the aptitude tests; a rights score and an error score. Intelligence test score and age were the other two variables. The scores were obtained on 194 high school commercial students. Three factors were obtained that were interpretable; perceptual analysis, speed, and comprehension of verbal relationships. The three factors accounted for only 41% of the total variance of the battery indicating that many of the tests were measuring abilities unique from the other tests. The factors did not seem to be identifying aptitudes that would serve as meaningful bases for clustering clerical occupations.

A cluster analysis of office operations was performed by Thomas (1952). One purpose of the study was to identify groups or clusters of similar elemental operations in a sample of office jobs. A 139 item check list of basic clerical operations was completed on 112 office jobs in five different companies. The check list was completed by each job incumbent and the immediate supervisor. Any points of difference between the incumbent and the supervisor were mediated by a research coordinator. Sixty of the items were dropped for the analysis because fewer than 20 of the 112 had checked the item. A correlation matrix of phi coefficients based on the 79 remaining items was analyzed with the Tryon Cluster Analysis technique. Eight clusters of office operations were identified; typing, listing and compilation, communication, planning and supervising, filing, stock handling, routine clerical and calculation.

Another analysis of clerical jobs to determine common worker functions and knowledge requirements was conducted by Chalupsky (1962). Two checklists were used to analyze a sample of 192 office jobs. One checklist contained 33 items dealing with worker functions and the other checklist had 58 items on clerical knowledge. The two checklists were analyzed separately. Four factors emerged that were common to both checklists, that is there were four common worker function and clerical knowledge factors. These were inventory and stockkeeping, supervision, computation and bookkeeping, and communications and public relations. In addition to these four factors, the knowledge checklist yielded a stenography-typing and a general clerical factor. These two factors corresponded to a single factor on the function checklist.

The Chalupsky and the Thomas studies had quite similar results, and it appears that there are some rather clear cut dimensions that can be used for classifying office occupations.

Job Perception and Theories of Occupational Development

Another approach to clustering jobs than by trying to identify common tasks or behavior in jobs is to cluster the jobs according to the perceptions held of the jobs by people. Included in this section then are reviews of some job perception studies and also reviews of some of the dominant theories of occupational development since the theories are seen to be attempts to classify occupations from perceived similarities. Hopefully the theories will stimulate research to test the hypothesized categorizations but little has been accomplished up to now.

Grunes (1956) conducted a study in an attempt to determine the job perceptions of young people and whether job perceptions are related to social class. One hundred fifty students from eight California high schools completed the Grouping Test and the Pick-A-Job Test. In the Grouping Test the task was to group 51 varied occupations in as many ways as the subject could think of. The Pick-A-Job Test required the respondent to suggest five appropriate jobs for a fictitious person who was briefly described. A method was developed for clustering the jobs named in the two tests. The identified clusters were professional, business, clerical, skilled, laborer requiring physical strength, social, and common labor requiring no special skills or strength. Several jobs did not fall into any of the clusters and perhaps would fall into other clusters if more jobs of such clusters were included in the tests. Some social class differences were observed in the job perceptions.

Triandis (1959) attempted to identify the categories of thought of managers, clerks, and workers about jobs. Twelve triads of jobs were presented to 105 persons who were asked, "Which one of these three jobs is more different from the other two?" and "Why?". From the protocols the investigators were able to define categories of thought which the subjects seemed to be using in judging job similarities and differences. The categories included indoors--outdoors, difficult--easy, skilled--unskilled, high--low pay, much--little education, much--no responsibility, desirable--undesirable, has--has no authority, employer--employee, travels--stays put, routine--variable, interesting--uninteresting and manual--mental. Other categories were used specifically by the managerial and the worker groups, but those listed above were common to both groups.

Gonyea (1961) and Gonyea and Lunneborg (1963) studied dimensions of job perceptions with a multidimensional scaling technique. The 1963 study, which was reviewed in the section of the report on factor analytic studies, was an attempt to refine certain procedures of the 1961 study in order to obtain a more definite factor structure. Gonyea did not attempt to name the factors obtained in the 1961 study, but an examination of the jobs that loaded on each factor suggests the following factors as some of the dimensions used by people in their perception of jobs: scientific and intellectual, managerial, technical, service, and independent.

The job perception studies have had results to indicate that there is a meaningful system by which people perceive and classify jobs. The Triandis study results also suggested that the precision of the perceptual categories is related to familiarity with the jobs being classified.

Attempts at formulation of theories of vocational development have resulted in a variety of occupational classification schemes within the theories although some of the theorists have alluded to occupational classes without specifying them. (c.f. Ginzberg, et. al. (1951) and Super (1953).

Roe (1954) offered a two-way classification scheme of eight groups by eight categories. The groups identify the primary focus of the activity in the occupation, i.e. physical, social welfare and personal service, persuasive--business, government--industry, mathematics--physical sciences, biological sciences, humanities, and arts. The levels define the type of function performed, i.e. innovative, transmission--professional, transmission--semi-professional, application--professional, application--semi-professional and entrepeneur, support and maintenance--skilled, support--semi-skilled, and support--unskilled. Why these particular group and level classifications were selected was not clear from the article except that the group categories were perhaps identified as factors common to a number of interest test factorizations.

A modification of Roe's scheme was proposed by Moser, Dubin, and Shelsky (1956). The authors attempted to use the Roe matrix in classifying occupational preferences of ninth grade boys. They found it difficult to make a distinction between transmission and application at the professional and semi-professional levels. They also felt that the innovative and independent responsibility level was an over-refinement and too few were encountered to provide a meaningful cell size. Consequently, the investigators reduced the level categories from eight to six with the six being professional and managerial I, professional and managerial II, semi-professional and small business, skilled, semi-skilled, and unskilled. The group or focus of activity categories were also revised and were made consistent with the DOT. The authors indicated some dissatisfaction with basing focus of activity factors on interest and personality dimensions and devised a focus of activity classification scheme based on the actual activity in which the individual is engaged. The categories of focus of activity were service, business contact, business organization, technology, outdoor, science, general cultural, and arts and entertainment. Evidence was presented that the modified scheme provided more reliable classification judgments than the Roe scheme.

Holland (1959) proposed a developmental theory of occupational choice that included a two dimensional system for classifying occupations. One dimension was presented as six categories of occupational environments. The environments were defined as motoric, intellectual, supportive, conforming, persuassive, and esthetic. The second dimension of the system was presented in terms of four levels within each environment. The levels were not named as such. Holland's theory differs in many respects from Roe's, but the occupational classification scheme in both seem to be quite similar.

The dimensions of a vocational development theory presented by Bordin, Nochmann, and Segal (1963) were such to reveal a very psychoanalytic orientation to occupational classification. They presented a scheme which provided for classification of occupations under the dimensions of nurturant, oral aggressive, manipulative, sensual, anal, genital, exploratory, flowing-quenching, exhibiting and rhythmic movements. An occupation was rated on each dimension in terms of the degree of involvement, the instrumental mode, the objects manipulated, the sexual mode of expression, and the type of affect involved i.e. affect experienced, reaction formation, or isolation. This approach, although interesting, does not yet appear to be very useful for classifying occupations because of the difficulty in measuring the dimensions that are proposed.

Occupational Classification in Curriculum Studies

Several investigators have been and are continuing to study the problem of occupational clustering in connection with the building of vocational curricula. Many of the investigators have studied agricultural occupations specifically in an attempt to identify competencies needed and activities engaged in by workers in such occupations. Although the studies have not been directed at classification per se, it is obvious that the identification of common competencies and activities among occupations is but one step removed from classifying the occupations.

Phipps and Fuller (1964) factor analyzed activity and knowledge scores separately for agriculturally related occupations. They identified 12 activity factors and 12 knowledge factors that could be used in classifying agricultural occupations.

A factor analysis of 63 job competencies in 125 job titles of agriculturally related occupations was reported by Stevenson (1965). The analysis yielded the following competency factors: human relations, salesmanship, business management, agricultural business management, plant and soil science, animal science, agricultural machinery, and construction technology.

A number of factor analyses of competencies and activities of agricultural workers have been done at Purdue University by Coster and Courtney (1965), Clouse and Coster (1965) and Coster and Pencod (1965). In the Coster and Courtney study, the data were ratings of each of 148 agriculturally oriented competencies needed by workers in three agriculturally oriented occupations; farmers, farm real estate brokers, and grain elevator operators. The data were collected from 40 persons in each occupation. The factor analysis yielded six interpretable factors. Three of the factors were judged to represent the three occupations and the other three indicated some commonality among the occupations in terms of agronomy, animal, and mechanical knowledges and competencies.

The Coster and Penrod and the Clouse and Coster studies confirmed the results of the study described above, except that the latter two studies did not obtain such clear cut occupational factors as the Coster and Courtney study. More occupations were included in the sample of workers and the occupations were more varied in terms of level in the latter two studies. The factors obtained crossed occupational lines, thus suggesting that a reasonable basis for clustering agriculturally related occupations exists in terms of the activities and competencies common to a number of the occupations.

A series of studies at Iowa State University have approached the problem of identifying the competencies needed by successful workers in various agricultural occupations. The occupations were rated in terms of competencies and abilities needed. The lists of competencies and abilities were rationally determined, and, although some clustering of occupations might be possible from the data, in their present form the data are not useful for such a purpose.

Shill and Arnold (1965) studied the common and specific knowledges across six technical specialties with an analysis of variance approach. Certain common knowledges were found in that the mean scores of the six specialties on certain knowledges did not differ significantly whereas on other scales there were differences.

A curriculum development project now in progress at Maryland is concerned with the approach of basing vocational curricula on job clusters (Frantz; 1966). The objective of the project is to develop curricula that prepare individuals for entry into any of several jobs in a job cluster. The approach being used in this project to establish job clusters seems to be primarily rational rather than empirical. It was interesting to note that the investigators rejected factor analysis or hierarchical grouping as techniques for clustering. The approach being used involved first the development of a task inventory. Each task is written in behavioral terms and then each task is judged or classified according to the human requirements for performing the task. The categories of human requirements are skills, mathematics, measurement, science, communication, and information. The basis for these categories was not clear in the available literature on the project. The human requirements for each task are then stated in behavioral terms. The job clusters will then be formed on the basis of frequency with which jobs are described by common human requirement behaviors. Three occupational clusters have been named in the project; construction, metal forming and fabrication, and electro-mechanical installation and repair. It would appear from the description of the project that these three clusters were formed on a rational basis and not from an application of the clustering technique described above. Evidently the clustering technique will be used to establish clusters within the three general occupational clusters. This reviewer wonders why the project does not use some technique such as hierarchical grouping for forming the clusters. The procedures seem to be very similar to those the Air Force uses up to the point of forming the clusters, and it would seem desirable to employ some mathematical criterion for clustering the jobs that is more precise than number of common statements. One wonders whether the technique will not yield many overlapping clusters or jobs loading on many clusters with a result that few meaningful clusters can be formed.

The American Institute for Research is working with the Quincy, Massachusetts, schools in a vocational curriculum development project (Morrison, 1966). One of the first phases of the project was to describe the structure of the domain of general vocational abilities as it might exist among high school students.

In this phase, 31 selected occupations were each analyzed and described in terms of the tasks required for the occupation. The tasks were then translated into human behaviors and these behaviors were stated as test items with some 20 items constructed for the behavior in each job. The 600 test items so constructed were administered to 10,000 students in grades 9 through 14. Mean scores of the students were compared by sex on each of the occupational subtests and expected differences were found. A conclusion of the study was that there is an orderly set of capabilities that are general over many common occupations. The capabilities were judged by four judges to be organized into six major areas: mechanical, electrical, spatial, chemical-biological, symbolic, and human relations. Further, it was found that variance on these capabilities among high school students was relatively independent of aptitude score variance. The study did demonstrate a reasonable basis for clustering jobs in the sense that behavioral descriptions of job tasks in terms of human requirements could be classified into six major areas. Further, when the requirements were written as test items it was demonstrated that the capabilities measured by the tests did serve to discriminate among students.

Discussion

As was expected, there were similarities and differences among the various approaches to job classification. The differing results likely resulted from many reasons included among which were the different instruments used, the different purposes of the studies, the different techniques of analysis, and the different jobs studied. To illustrate, the job evaluation studies generally identified a skill factor as one factor for job evaluation. On the other hand the studies of clerical jobs were primarily concerned with analyzing the skill factor in clerical jobs. Consequently, these studies employed instruments and techniques that were designed to analyze the skill dimension more comprehensively than was done in the job evaluation studies. The analyses of the clerical jobs did result in the identification of several skill dimensions.

The job analysis studies cited in the first part of this section seemed to be most relevant for our purpose. The results of the job analysis studies suggested that job behaviors can be thought of in terms of five major dimensions; physical behaviors, basic intellectual behaviors, discrimination behaviors, decision making and responsibility behaviors, and communication behaviors.

The following lists contain the identified factor titles in the job analysis studies that we classified under the five major dimensions. The number in the parenthesis is the bibliography number of the referenced study in which the factor was identified.

A. Physical behaviors

1. Body agility (58)
2. Heavy manual work vs. clerical ability (58)
3. Strength (48)
4. Manual dexterity (48)
5. Mechanical-manual (67)
6. Physical output (41)
7. Sedentary vs. physical work activity (68)
8. Skilled physical activities (14) (42)
9. Mental vs. physical activities (14) (42)
10. Skilled machine operation (11)

B. Intellectual behaviors

1. Mental and educational development vs. adaptability to routine (58)
2. Intelligence (48)
3. Knowledge of tools vs. mathematics (68)

4. Mediation (41)
5. Mechanical information (48)
6. Mental vs. physical activities (14) (42)
7. Adaptability to precision operations (58)
8. Manual art ability (58)
9. Intellectual-supervisory (67)
10. Man-machine control activities (14) (42)

C. Discrimination behaviors

1. Adaptability to precision operations (58)
2. Artistic ability and esthetic appreciation (58)
3. General mechanical activities and inspection (51)
4. Inspection (48)

D. Decision making and responsibility behaviors

1. Diagnostic and analytic activities (51)
2. Self-responsibility (11)
3. Intellectual-supervisory (67)
4. Mediation (41)
5. General decision making and mental activity (68)
6. Decision making and communication (14) (42)
7. Responsible personal contact (14) (42)

E. Communication behaviors

1. Personal contact ability vs. adaptability to routine (58)
2. Intellectual-supervisory (67)
3. Communications (41)
4. Communications in business management and information in routine physical work (68)
5. Decision making and communication (14) (42)
6. Hierarchical person-to-person interaction (14) (42)
7. Responsible personal contact (14) (42)

In addition to the factors listed and classified above there were some clerical factors and job environment factors identified.

Clerical behaviors were studied specifically by three of the reported studies and the following list is of the dimensions of clerical behavior.

1. Perceptual analysis (4)
2. Speed (4)
3. Verbal comprehension (4)
4. Typing (7) (79)
5. Listing and compilation (7) (79)
6. Communications (7) (79)
7. Planning and supervising (7) (79)
8. Filing (79)
9. Computation and bookkeeping (7)

Although many of these clerical behaviors could be subsumed under some of the behavioral dimensions listed earlier, it does seem reasonable to consider some measure of clerical behaviors separately if it is likely that clerical type jobs will be included in a study.

Job environment factors were often identified in the job evaluation studies. The factors of job environment are listed below.

1. Hazardous job characteristics (50) (51) (59)
2. Non-hazardous job characteristics (50) (51)
3. Work conditions (66) (43)
4. Physical components (64)
5. Responsible for others safety (59)

Such job environment factors likely should be considered in a job analysis study because of the strong likelihood that variance in the job environment is related to variance in job behaviors.

The other factors identified in the job evaluation studies were either very similar to or more general than those identified in the job analysis studies and are considered further because of the better precision of definition in the job analysis studies.

The theoretical, job perception, and curriculum studies, although of interest, described classification systems or factors that were too general to be of use in describing jobs in terms of behaviors.

Thus on the basis of the review, it appeared reasonable that for our study, which is concerned with the identification of behavioral factors, the five general behavioral dimensions provided a useful starting point for developing an instrument for measuring job behaviors. In addition to the five general dimensions, the review also suggested that clerical behaviors and job environment characteristics might also be measured.

The review of the studies provided little indication of the relative merits of various job grouping procedures. Factor analysis was the most commonly used method, and it does seem to be the method that will identify commonality among jobs most readily. The hierarchical groupig procedure used by the Air Force, however, does have promise for job clustering, and we do hope to try it in our project along with the factor analysis.

The Air Force studies contained considerable evidence on measurement of job behaviors. The studies indicated that rating scales can be used reliably for measuring job behaviors and that the judgments need not be based on job observations but can be obtained reliably from job descriptions and interviews. One job judgment that was not rated reliably was judgment of job difficulty, but frequency, time, job evaluation factors, and ability requirements were judged reliably with rating scales. The evidence supported our decision to measure most job behaviors with a rating scale.

PSYCHOMOTOR STUDIES

When considering the problem of classifying jobs on the basis of common behaviors in the jobs, we became aware of the desirability of being able to name the categories without reference to any specific job. As this line of thinking was extended it soon became obvious that we were approaching the problem in terms of basic human abilities or behaviors. The limitation of this approach for our purposes was that although it would be useful to describe or categorize jobs in terms of basic cognitive and psychomotor abilities, the term abilities connotes a certain genetic limitation, and we were looking for dimensions which could be considered to be environmentally determined and thus the development or training of which could be provided for in an educational program. Abilities are developed in a facilitating environment, however, and although the term implies a genetic limitation, it did not seem unreasonable to consider basic cognitive and motor abilities as being of use in classifying jobs. Many of the job analysis studies cited in the previous section of this report contained descriptions of factors or dimensions that could be considered descriptions of cognitive or motor abilities. From this line of thinking we decided it desirable and necessary to review some of the literature on motor and cognitive abilities to determine what relevance it might have for our problem. Another reason for reviewing this literature was that one objective of this project was to attempt to determine the extent to which job dimensions had common variance with basic motor and cognitive factors regardless of whether the basic factors would be meaningful job classification dimensions in their own right.

This section of the report contains a review of some studies on psychomotor abilities and the next section deals with cognitive abilities.

One of the most productive researchers in studying the structure of psychomotor abilities has been Fleishman. Several of the studies reported by him and associates are reviewed first.

An early report by Fleishman (1953A) presented a discussion of the use of apparatus tests for testing psychomotor abilities. He indicated that tasks such as perceptual-motor coordination, smoothness of control movement, speed of discriminative reactions, appropriateness of control movement, responsiveness to kinesthetic cues, and motor control under stress conditions were appropriately measured with apparatus tests rather than printed tests because they involved making rather than selecting a response. Some problems encountered in using apparatus tests, according to Fleishman, were expense, determination of reliability and validity, and the length of time involved in administration. A discussion of factor analyses of psychomotor tests was also presented in the paper. Difficulty in interpreting such analyses was discussed in terms of the different factor analysis methods used by the investigators and the different interpretations provided for factors.

Several of the studies by Fleishman were attempts to identify basic psychomotor factors from psychomotor test performances. In one study, Fleishman (1953B) factor analyzed correlation matrices obtained from six administrations of the Standard Rudder Control test and four administrations of the Six-Target Rudder Control test. Two matrices were analyzed one of which was based on a sample of pilot cadets who took the Standard Rudder Control Administration first and the other was based on a sample of cadets who took the Six-Target Rudder Control administrations first. The total sample size was 698. The analyses of the two matrices each yielded three factors and the factors were nearly identical. The basic psychomotor factors measured by the two tests as named by Fleishman were precision of movement, steadiness-control, and strength.

In another article, Fleishman (1954) reported a comprehensive study that attempted to define a functional classification of abilities that would be useful catefories for describing performance in a wide variety of psychomotor tasks. A bettery of 38 specially designed apparatus and printed tests was constructed. At least three tests were constructed to sample abilities in each of seven areas that were essentially hypothesized factors of psychomotor abilities. The hypothesized factors were reaction time, speed of movement, manual dexterity, finger dexterity, precision of movement, aiming, and motor-kinesthesis. The test battery was administered to 400 basic trainee airmen and the correlation matrix was factor analyzed. Eleven factors were identified in the analysis rather than the seven hypothesized. The factors as named were wrist-finger speed, finger dexterity, rate of arm movement, aiming, arm-hand steadiness, reaction time, manual dexterity, psychomotor speed, psychomotor coordination, spatial relations, and postural discrimination.

Twenty-three variables were used in another study in the same vein by Fleishman and Hempel (1954A). The 23 variables included 16 apparatus tests and seven printed tests which were administered to 1,000 Naval Cadets. The factor analysis yielded nine factors which were named psychomotor coordination I, psychomotor coordination II, integration, rate control, perceptual speed, manual dexterity, and visualization.

A correlation matrix based on 15 dexterity tests was analyzed by Fleishman and Hempel (1954B). The tests were administered to a sample of 400 basic airmen. The factor analysis resulted in the identification of five dexterity factors which were named finger dexterity, wrist-finger speed, aiming, manual dexterity, and positioning.

Fleishman and Hempel (1954C) in another study investigated the problem of whether different psychomotor factors account for variance in a psychomotor task at different stages of learning the task. One hundred ninety-seven basic trainee airmen were given practice on the Complex Coordination Test and measures of their performance on the test were taken at eight stages. These measures were correlated with their performances on 12 printed tests and six apparatus tests of motor ability. The analysis of the 26 x 26 matrix yielded nine factors which were named complex coordination, psychomotor coordination, rate of movement, spatial relations, perceptual speed, visualization, mechanical, numerical, and psychomotor speed. The learning tasks measures loaded on the first three factors primarily with little evidence of change of factors involved in the task with practice.

Hempel and Fleishman (1955) reported a factor analysis of 46 measures of physical proficiency and manipulative skill. The 46 tests included 17 manipulative apparatus tests, six printed tests, and 23 gross physical performance tests. The battery was administered to a sample of 400 basic airmen. Fourteen factors were named and accounted for most of the variance on the 46 psychomotor tests. The factors were named as follows: aiming, limb strength, gross body coordination, equilibrium balance, energy mobilization, trunk strength, reasoning, leg suppleness, arm-hand steadiness, trunk flexibility, manual dexterity, dynamic balance, finger dexterity, and jump performance. The investigators concluded that the gross physical factors and the manipulative factors were relatively independent. They grouped the physical performance factors under five general categories of strength, flexibility, balance, gross body coordination, and energy mobilization. The manipulation factors were also grouped into four general categories of manual dexterity, finger dexterity, arm-hand steadiness, and aiming.

The relationship between psychomotor factor structure and task difficulty was the problem of another study by Fleishman (1957). Twelve psychomotor tests were administered to 200 basic trainee airmen. Each airman also had a score on each of eight conditions of a Response

Orientation Test. The 20 measures were intercorrelated and the ensuing matrix was factor analyzed. Four factors were named of the six extracted. The factors were spatial, visualization, response orientation, and speed.

Nine printed and twelve apparatus tests were used by Fleishman and Ellison (1962) in a study of fine manipulative tasks. The tests were administered to 760 airmen. Five factors were identified from the data; wrist-finger speed, finger dexterity, speed of arm movement, manual dexterity, and aiming. It was concluded in the study that printed manipulative tests are often used inappropriately in that they do not seem to measure many of the traits they are purported to measure such as motor speed, eye-hand coordination, finger dexterity, and manual dexterity. The only factors associated with the printed tests in the study were wrist-finger speed and aiming.

Fleishman and associates have conducted some studies in which attempts were made to identify psychomotor and cognitive factors associated with performances in certain jobs. One such study was concerned with aptitudes in radiotelegraphy (Fleishman, Roberts, and Friedman, 1958). A battery of 14 tests was administered to 310 airmen prior to their entering a radio operator training course. Five of the tests were auditory, and nine were printed, but each was hypothesized to be predictive of success. The 14 tests and a measure of proficiency in learning the code were intercorrelated and the matrix was analyzed. Five factors were identified; visualization, verbal ability, auditory rhythm perception, speed of closure, and auditory perceptual. The proficiency measure loaded on the last three factors named.

Four measures of proficiency in learning the Morse code were obtained in the same training course. The measures were the number of days needed to achieve four levels of proficiency by each airman. The four measures were correlated with the 14 aptitude measures and also loadings for the four measures were projected on the five factors identified in the study reported in the preceding paragraph. The results of the Morse code study were presented by Fleishman and Fruchter (1960). No new factors were identified in the Morse code study. It was found that the auditory rhythm and auditory perceptual factors were predictive of proficiency with Morse code in the early stages of training and the speed of closure factor predicted performance at the intermediate stages. The last measures of code proficiency, however, were not predictable by any of the identified factors.

Other Studies of Psychomotor Abilities

Seashore, Buxton, and McCollom (1940) administered 21 tests of fine motor skills to 50 men. A factor analysis of the intercorrelations of the tests revealed five interpretable factors to account for the variance of the 21 tests. The factors were speed of single reaction, finger-hand speed, forearm-hand speed, steadiness, and manipulation of spatial relations.

Mechanical ability tests were analyzed by Harrell (1940). Thirty-seven tests were administered to 91 cotton mill machine fixers. The identified factors in the analysis were perceptual, verbal, youth or maturation, manual dexterity, and spatial. The mechanical ability tests loaded most heavily on the perceptual and spatial factors.

Reynolds (1952) studied the effect of learning on the predictability of psychomotor performance. Six scores on the Complex Coordination Test obtained after successive one hour practice periods were correlated with printed tests of the Airman Classification Test Battery. A sample of 149 basic trainee airmen was used. The results were similar to those of Fleishman in that the predictive tests were useful for predicting early performances on the Coordination Test but had little predictability for the later performances. Further the early performances on the Coordination Test had only low correlations with the later performances.

Fifteen dexterity tests were analyzed by Bourassa and Guion (1959). The tests were selected or constructed to measure five hypothesized dexterity factors of manual, finger, tweezer, visual, and depth perception. The tests were given to 100 female undergraduates. Five factors were obtained but only three allowed interpretation. The three factors named were manual dexterity, visual sensitivity, and visual feedback. It was noted that a finger dexterity factor which had been identified in a number of studies did not appear in this study.

Discussion

The various factor analyses of psychomotor tests reported results that indicate that the factor structure obtained in an analysis is very much a function of the measures used. Several factors were identified rather consistently by the investigators, however, and these factors were suggestive of behaviors that could be measured in connection with a job especially in the physical and discrimination areas. Physical or motor factors that appeared quite consistently were given various names but seemed generally to be involved with finger movement, arm-hand movement, foot-leg movement, manual dexterity or motor coordination and general bodily activity. Discrimination or perceptual factors were identified in the areas of spatial relations, visualization, auditory perception, positioning and balance, and response orientation. In our development of the instrument we attempted to include items that measured each of these behaviors.

Many of the factors identified in the psychomotor studies that were reviewed did not seem to be so much a single behavioral dimension as a dimension on which many behaviors might be scaled. Factors of this type were various strength, speed, and precision factors. As will be evident in the description of the instrument, which is in a later section of this report, we decided to consider such dimensions as scales on which the behaviors could be rated along with some other scales.

The review of the psychomotor literature reinforced our belief that certain tests of psychomotor ability might well be used in determining those abilities that are associated with particular job behaviors. The second phase of our research project will attempt to study this question. We will select a test that defines or loads heavily on a particular factor and include this test score with the measures of job behaviors in the analysis. This procedure should allow us to identify the psychomotor factor or factors required in the job behaviors.

COGNITIVE FACTORS

Since the early work of Spearman, many investigators have devoted their efforts to the study of mental abilities. As a consequence the cognitive realm of human behavior is more well defined today than any other aspect of behavior although certainly much work remains to be done.

In considering the problem of identifying cognitive factors that might be associated with certain job behaviors, we first attempted to review the literature on the identification of cognitive factors. It soon became obvious that such a task was impossible; the writing in this area is voluminous. Further, we decided that such a review was unnecessary for the purposes of the study because several reviews and books have been written about the cognitive domain which have drawn together and synthesized the research findings in the area.

Our primary concern was first to identify those cognitive factors that have been identified by a number of studies and that are regarded as being quite well established as dimensions of intellective behavior. A manual developed by French, Ekstrom and Price (1963) contains a list of aptitude and achievement factors that were considered to be the better established factors in the cognitive area by a committee of the leading investigators of the cognitive domain. The manual also contains descriptions of the factors. The factors named in the manual are listed below:

Flexibility of Closure
Speed of Closure
Associational Fluency
Expressional Fluency
Ideational Fluency
Word Fluency

Induction
Length Estimation
Rote Memory
Mechanical Knowledge
Memory Span
Number Facility
Originality
Perceptual Speed
General Reasoning
Semantic Redefinition
Syllogistic Reasoning
Spatial Orientation
Sensitivity to Problems
Spatial Scanning
Verbal Comprehension
Visualization
Figural Adaptive Flexibility
Semantic Spontaneous Flexibility

Although these 24 factors may not describe the domain of cognitive abilities completely (c.f. Guilford, 1952) the list does seem to be quite comprehensive.

Many of the factors in the list do not lend themselves to measurement by observation of behavior or through job analysis procedures. We have, however, used this list as a basis for inclusion of certain behaviors in our instrument for analyzing jobs. In the second phase of the study we intend to use some of the tests which measure these factors in an attempt to determine what job behaviors might load on the various cognitive factors.

INSTRUMENT DEVELOPMENT

The review of the job analysis, psychomotor, and cognitive literature provided the basis for the development of the instrument for our study. As we considered the problem of attempting to identify job clusters as a basis for curriculum development it seemed desirable to attempt to cluster jobs on the basis of common behaviors rather than on the basis of job tasks and elements. The reasoning was that the purpose of an educational or a training program is to change behavior, consequently the curriculum ought to be designed to train in terms of behavior rather than in terms of duties or tasks.

The five general behavioral areas suggested by the job analysis studies were used as the general outline of the instrument. Each of the areas is discussed below in terms of the specific behaviors included for measurement.

Many of the factors identified in the psychomotor studies were considered to be those physical behaviors that would be meaningful for grouping jobs. Accordingly we included in the instrument items on finger manipulation, arm-hand manipulation, foot-leg manipulation, general body activity, and motor coordination. We also included under the physical behaviors category items on motor control operations, object assembly, and hand tool usage. These items, which have been used in previous studies, were included to get a measure of more general job tasks that should be dependent upon the more basic physical behaviors. The three selected general tasks were judged to be those that would occur most commonly among the jobs to be studied.

The items in the discrimination behavior area also were selected on the basis of the results of the psychomotor studies. Visualization was divided into a near visual and far visual item. Depth discrimination and estimation of speed were included as behaviors involved in spatial relations. Color, sound, odor, taste, and tactual discrimination items were also included along with a blind positioning item. Items on estimation or inspection and monitoring of work processes were included under the discrimination dimension as more general job tasks that would require the exercise of one or more discrimination behaviors.

The intellectual behaviors were not identified so much from the cognitive factors as from items in the job analysis study instruments. Several knowledge items were used including knowledge of mathematics, machine operation, machine repair, characteristics of finished product, characteristics of product components, processes, and business procedures. Verbal behavior was provided for by items on reading and interpretation and following instructions. Other intellective items were on visualization of relationships, close concentration, and reasoning and problem solving.

The responsibility and decision making behavior items were taken from job analysis instruments and were those that seemed most relevant to the jobs to be studied. The items were formulation of policies or goals, making work assignments, forecasting needs, inspection, and ordering and buying.

The communication behavior items were selected on the same basis as the responsibility and decision making behaviors and included supervision or training of workers, origination of written communications, communication by other than oral or written means, persuasive communication, and service.

After defining the behaviors that were of concern on the job, the next problem was to decide how these behaviors were to be measured. As mentioned earlier, some of the factors that were identified in the job analysis and in the psychomotor studies seemed to be dimensions along which behaviors might be measured. These dimensions were speed, frequency, precision, and strength. In addition it seemed reasonable that many or most of the behaviorsmight also be measured in terms of the variety of ways in which the behavior was used, the importance of the behavior to the job, and the complexity of the behavior.

The first form of the instrument included all of the behaviors in the list and for each behavior a rationally developed four point scale was used to measure variety, precision, importance, speed, frequency, and complexity. A strength scale was also used for the physical behavior items. Each scale contained general statements to define the points.

The tryout of this form revealed certain failings of the instrument among which were the following points:

1. A judgment of variety along a scale was difficult and a more reasonable response was obtained by asking the person to name the ways in which they perform this behavior. A count of the ways provides a measure of variety.

2. A general precision scale was not meaningful and this scale was responded to more meaningfully when we developed five scales of precision; mathematics usage, application of knowledge, interpretation, physical movements, and discrimination.

3. Importance to the job is difficult to scale because the incumbent seems to consider anything he does to be important. Some variance was obtained, however, so we decided to keep the scale in the instrument.

4. The speed and strength scales as written were responded to quite meaningfully when appropriate.

5. Frequency is not easily scaled. We decided to leave frequency open-ended and post code the responses on a four point continuum.

6. Complexity also is not easily scaled. The complexity scale can be used as a post-coding device on the basis of a judgment from the responses to the ways the behavior is done on the job.

7. Not all scales were appropriate for all items. Appendix A is a schematic of the behaviors and the scales used for each behavior.

This early tryout consisted of 30 interviews. On the basis of these early interviews the instrument was revised to the form shown in Table 1.

Beside the behaviors the instrument also called for responses on items relevant to the job as a whole and a check list of activities performed on the job. These were included in an attempt to get at certain job characteristics that might be related to the behavioral factors, especially job environment factors. The check lists also included many clerical, physical, and communication behaviors and should provide for enough redundancy to allow for every significant factor to emerge in the factor analysis.

The final report of the project will include a description of the instrument development from the formal tryout to the development of the final form.

TABLE I

Outline of Behaviors Included in the Instrument and the Scales Used to Measure Each Behavior

	Variety	Precision	Importance	Speed	Frequency	Strength	Complexity
A. Physical Behavior							
1. Finger manipulation	x	x	x	x	x	x	x
2. Arm-hand manipulation	x	x	x	x	x	x	x
3. Foot-leg manipulation	x	x	x	x	x	x	x
4. Motor coordination	x	x	x	x	x	x	x
5. General body activity	x	x	x	x	x	x	x
6. Motor control	x	x	x	x	x	x	x
7. Object assembly	x	x	x	x	x	x	x
8. Hand tools	x	x	x		x	x	x
B. Discrimination Behavior							
1. Near visual	x	x	x	x	x		x
2. Far visual	x	x	x	x	x		x
3. Depth	x	x	x	x	x		x
4. Speed estimation	x	x	x	x	x		x
5. Estimation of quality and quantity	x	x	x	x	x		x
6. Color	x	x	x	x	x		x
7. Sound	x	x	x	x	x		x
8. Odor	x	x	x		x		x
9. Taste	x	x	x		x		
10. Factual	x	x	x		x		x
11. Blind positioning	x	x	x	x	x		x
12. Monitoring	x	x	x	x	x		x
C. Intellectual Behavior							
1. Math usage	x	x	x	x	x		x
2. Machine operation	x	x	x		x		x
3. Machine repair	x	x	x		x		x
4. Finished product	x	x	x		x		x
5. Materials	x	x	x		x		x
6. Processes	x	x	x		x		x

	Variety	Precision	Importance	Speed	Frequency	Strength	Complexity
7. Business procedures	x	x	x		x		x
8. Read and interpret	x	x	x		x		x
9. Receive instructions	x	x			x		x
10. Visualize relationships	x		x		x		x
11. Close concentration	x		x		x		x
12. Reasoning	x		x	x	x		x
D. Responsibility and Decision Making							
1. Formulate policies and goals	x	x	x		x		
2. Make work assignments	x	x			x		x
3. Forecast needs	x	x	x		x		x
4. Inspection	x	x	x		x		x
5. Ordering	x	x	x		x		x
E. Communication Behavior							
1. Supervise or train	x	x	x		x		x
2. Originate written comm.	x	x	x		x		x
3. Comm. other than oral or written	x		x		x		x
4. Persuasive comm.	x		x		x		x
5. Service	x		x	x	x		x

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